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January 2001



Science 30
Grade 12 Diploma Examination

Alberta
LEARNING

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Science 30

Grade 12 Diploma Examination

Description

Time: This examination was developed to be completed in 2.5 h; however, you may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 40 multiple-choice and 12 numerical-response questions of equal value, worth 65% of the examination
- 1 short-answer question and 2 long-answer questions, worth 35% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

A science data booklet is provided for your reference.

Note: The perforated pages at the back of this booklet may be torn out and used for your rough work. **No marks** will be given for work done on the tear-out pages.

Instructions

- You are expected to provide your own calculator. You may use any scientific calculator or a graphing calculator approved by Alberta Learning. **NEW**
- You are expected to have cleared your calculator of all information that is stored in the programmable or parametric memory. **NEW**
- Use only an HB pencil for the machine-scored answer sheet.
- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- Read each question carefully.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- When performing calculations, use the values of the constants provided in the data booklet. Do **not** use the values programmed in your calculator.
- If you wish to change an answer, erase **all** traces of your first answer.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Learning.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A.** science
B. biology
C. physics
D. chemistry

Answer Sheet

☒ (A) ☐ (B) ☐ (C) ☐ (D)

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Record your **three-digit** answer in the numerical-response section on the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7 \text{ (rounded to three digits)}\end{aligned}$$

Record 23.7 on the answer sheet —

2	3	.	7
	.		
0	0	0	0
1	1	1	1
	2	2	2
3		3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	
8	8	8	8
9	9	9	9

Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____, _____, _____, and _____.

- 1 physics
- 2 biology
- 3 science
- 4 chemistry

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

Answer: 2413

Record 2413 on the answer sheet →

2	4	1	3
•	•		
0	0	0	0
1	1	●	1
●	2	2	2
3	3	3	●
4	●	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must address **all** aspects of the question.
- Descriptions and/or explanations of concepts must be correct and include pertinent ideas, diagrams, calculations, and formulas.
- Your answers must be presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.

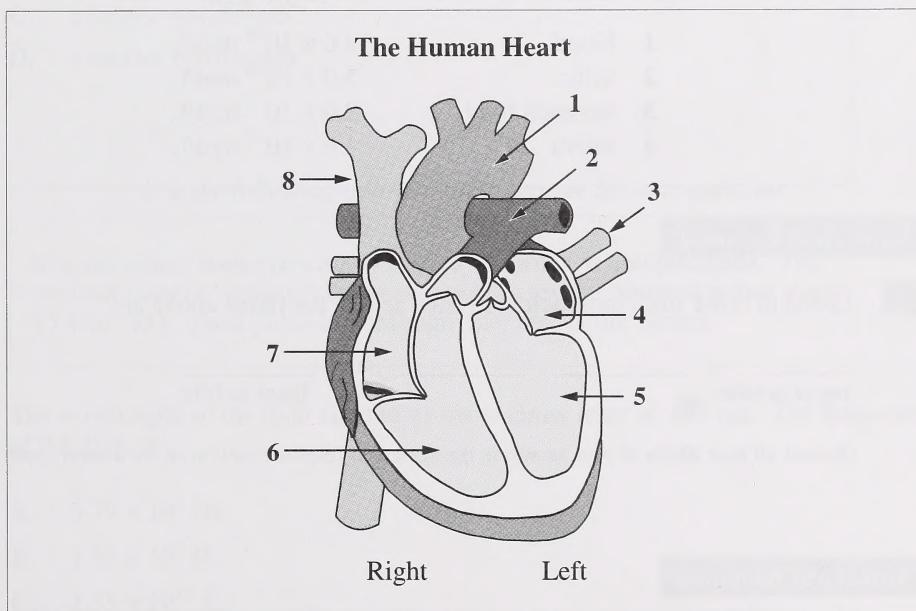


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Doctors and technicians at a medical clinic treat and counsel patients and carry out technical procedures during their daily routines.

1. Blood clotting factors are routinely tested. Clotting is initiated by
- A. platelets
 - B. helper T cells
 - C. red blood cells
 - D. white blood cells

Use the following information to answer the next two questions.



Numerical Response

1. The heart pumps both oxygenated and deoxygenated blood. Which of the structures labelled above contain oxygenated blood?

Answer: _____

(Record **all four digits** of your answer in any order in the numerical-response section on the answer sheet.)

2. When blood flows from the lungs, through the heart, to the body tissues, it travels through, respectively, the
- A. atrium, ventricle, and aorta
 - B. ventricle, aorta, and atrium
 - C. aorta, atrium, and ventricle
 - D. atrium, aorta, and ventricle

Use the following information to answer the next two questions.

Normal Hydronium Ion Concentration $[\text{H}_3\text{O}^+_{(aq)}]$ of Some Body Fluids

	Fluid	$[\text{H}_3\text{O}^+_{(aq)}]$
1	blood	4.0×10^{-8} mol/L
2	urine	5.0×10^{-6} mol/L
3	stomach fluid	2.0×10^{-2} mol/L
4	saliva	1.6×10^{-7} mol/L

Numerical Response

2. Listed in order from most acidic to least acidic, the fluids above are:

_____, _____, _____, and _____.
most acidic **least acidic**

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

Numerical Response

3. According to the chart above, the pH of the urine is _____.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

3. A doctor tests a patient's reflexes by tapping the leg just below the knee. The four components of the nervous system responsible for the movement of the leg, listed in order from the reception of the stimulus to the response, are
- A. sensory receptor, sensory neuron, motor neuron, and spinal cord
 - B. motor neuron, interneuron (association neuron), spinal cord, and muscle
 - C. sensory neuron, interneuron (association neuron), motor neuron, and muscle
 - D. interneuron (association neuron), motor neuron, sensory neuron, and muscle
4. Cataracts may be caused by infrared radiation with a wavelength of 800 nm to 1 400 nm. Compared with visible light, infrared radiation has
- A. more energy
 - B. a higher frequency
 - C. a longer wavelength
 - D. a shorter wavelength

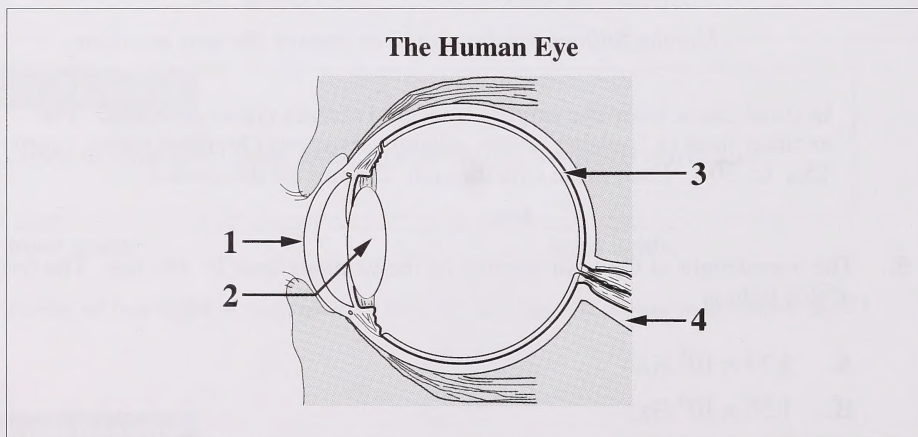
Use the following information to answer the next question.

In some cases, laser eye surgery is used to correct vision problems. The excimer laser (a "pulsing" laser) administers several hundred pulses every 15 s to 30 s. Each pulse cuts through 250 nm of the cornea.

5. The wavelength of the light emitted by the excimer laser is 193 nm. The frequency of this light is
- A. 5.79×10^1 Hz
 - B. 1.55×10^6 Hz
 - C. 1.55×10^{15} Hz
 - D. 6.43×10^{-16} Hz

6. Light entering the eye strikes the light-sensitive rods and cones in the retina. Which of the following statements describes the properties of these receptor cells?
- Rods are sensitive to dim light and colour.
 - Cones are sensitive to bright light and colour.
 - Neither rods nor cones are sensitive to colour.
 - Rods and cones are both sensitive to light and colour.
7. When light passes through the cornea and lens, it bends. This bending of light is called
- reflection
 - refraction
 - total internal reflection
 - total internal refraction

Use the following information to answer the next question.



Numerical Response

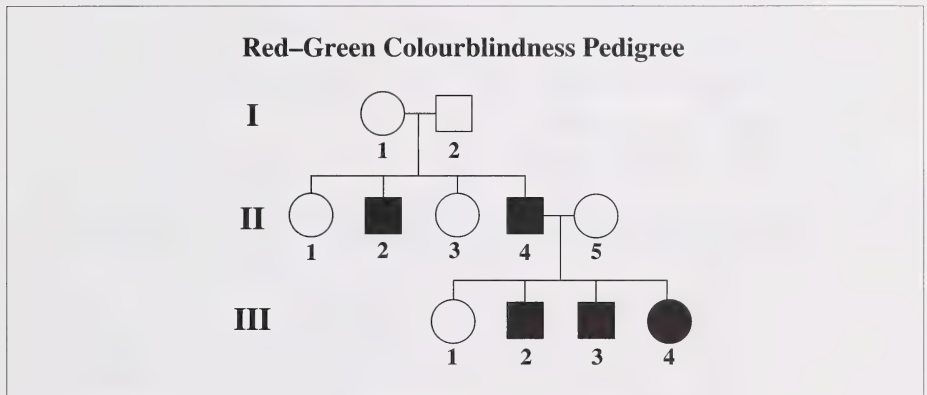
4. Match the eye structure, as labelled above, with the name of the structures given below.

Retina	_____	(Record in the first column.)
Lens	_____	(Record in the second column.)
Cornea	_____	(Record in the third column.)
Optic Nerve	_____	(Record in the fourth column.)

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

8. The eye structure that changes shape in order to focus on distant or close objects is the
- A. lens
 - B. retina
 - C. cornea
 - D. optic nerve

Use the following information to answer the next two questions.



9. A doctor used the colourblindness pedigree above to trace red-green colourblindness in a family. According to this pedigree, how many women in the family are colourblind?
- A. One
 - B. Four
 - C. Five
 - D. None
10. The genotype and phenotype of **II-5** are, respectively,
- A. homozygous and colourblind
 - B. heterozygous and colourblind
 - C. homozygous and not colourblind
 - D. heterozygous and not colourblind

- 11.** A child receives DNA from his or her father as a result of
- A.** gene splicing
 - B.** crossing-over
 - C.** meiosis and fertilization
 - D.** mitosis and cell division
- 12.** Some drugs, such as insulin, are proteins and are injected rather than taken orally. Ingestion of this type of drug is not successful because of the
- A.** action of macrophages
 - B.** low pH of the stomach
 - C.** neutral pH of the blood
 - D.** action of memory B cells

Use the following information to answer the next two questions.

A group of medical students designed an experiment to investigate the relationship between exercise and blood pressure. They measured the blood pressure of 10 healthy students at rest, and measured it again immediately after the students ran for five minutes.

13. The manipulated variable in this experiment is
- A. exercise
 - B. blood pressure
 - C. the number of students
 - D. the health of the students
14. As the level of exercise increases, oxygen demand in the muscles increases. Oxygen exchange between blood and muscles occurs as blood flows through the
- A. veins
 - B. arteries
 - C. venules
 - D. capillaries

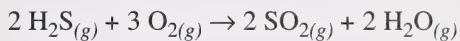
The petroleum industry in Alberta provides many benefits; however, it also produces some environmental and safety concerns.

15. When geologists search for oil, they study rock formations. Instruments at Earth's surface record and analyze radiation emitted by rocks. The instrument that is used to record the emitted radiation is a
- A. laser
 - B. telescope
 - C. spectrometer
 - D. fission reactor
16. In Alberta between 1976 to 1996, 32 workers died after inhaling hydrogen sulfide gas ($\text{H}_2\text{S}_{(g)}$). Hydrogen sulfide enters the body through the lungs and is first dissolved in the
- A. platelets
 - B. blood plasma
 - C. red blood cells
 - D. white blood cells

Use the following information to answer the next question.

As a safety feature in gas plants that process natural gas containing $\text{H}_2\text{S}_{(g)}$, the gas undergoes complete combustion in a flare stack rather than being released into the atmosphere.

Complete Combustion of $\text{H}_2\text{S}_{(g)}$



17. The products of this combustion significantly contribute to
- A. acid deposition
 - B. global warming
 - C. ozone depletion
 - D. photochemical smog

Use the following information to answer the next two questions.

Corrosive Material Symbol



18. Which of the following chemicals might a container labelled with the symbol shown above contain?

- A. $\text{CH}_{4(g)}$
- B. $\text{NaOH}_{(aq)}$
- C. $\text{CH}_3\text{OH}_{(l)}$
- D. $\text{C}_6\text{H}_{12}\text{O}_{6(s)}$

Use the following additional information to answer the next question.

Processes

- I Neutralization
- II Dehydration
- III Dilution
- IV Titration

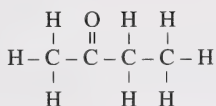
19. If a corrosive substance were accidentally spilled, which two processes numbered above would be the **most useful** in treating this spill?

- A. I and III
- B. I and IV
- C. II and III
- D. II and IV

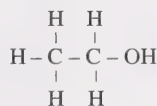
Use the following information to answer the next two questions.

Structural Formulas of Compounds That are Important in the Petrochemical Industry

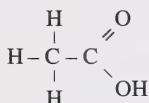
1



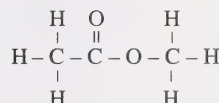
2



3



4



Numerical Response

5. Match the structural formulas of the compounds numbered above with the corresponding functional groups given below.

Carboxylic acid	_____	(Record in the first column.)
Ester	_____	(Record in the second column.)
Ketone	_____	(Record in the third column.)
Alcohol	_____	(Record in the fourth column.)

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

20. What is the name of compound 2?

- A. Ethanol
- B. Ethanal
- C. Ethanone
- D. Ethanoic acid

Use the following information to answer the next two questions.

The land around a drill site must be replanted. A horticulturist crossed two red-flowering shrubs. The seeds from the cross produced 100 shrubs, of which 73 were red-flowering and 27 were white-flowering.

21. Which of the following Punnett squares could be used to explain the results?

A.

	R	R
R	RR	RR
r	Rr	Rr

B.

	r	r
R	Rr	Rr
r	rr	rr

C.

	R	r
R	RR	Rr
r	Rr	rr

D.

	R	R
R	Rr	Rr
r	Rr	Rr

Numerical Response

6. If one of the original red-flowering shrubs was crossed with a white-flowering shrub, what percentage of the offspring will be white-flowering shrubs?

Answer: _____%

(Record your answer to three digits in the numerical-response section on the answer sheet.)

Care of the environment is an issue for industry, politicians, and all citizens.

22. The use of chlorinated organic compounds to bleach wood pulp is no longer necessary because of the development of new technologies. Chlorinated organic compounds should **not** be allowed to enter a river because they
- A. act as buffers, reducing nutrient availability
 - B. biodegrade rapidly and form insoluble materials
 - C. react with organic substances, reducing biological oxygen demand
 - D. do not readily biodegrade so they will biomagnify in the food chain
23. Bacteria in waste treatment lagoons use organic compounds for energy. In one stage of metabolism, a bacterial enzyme converts ethanol to ethanal. Which of the following rows gives the reactant and product in this reaction?

Row	Reactant	Product
A.	$\text{C}_2\text{H}_5\text{OH}_{(aq)}$	$\text{CH}_3\text{CHO}_{(aq)}$
B.	$\text{CH}_3\text{CHO}_{(aq)}$	$\text{C}_2\text{H}_5\text{OH}_{(aq)}$
C.	$\text{CH}_3\text{COOH}_{(aq)}$	$\text{CH}_3\text{COCH}_3_{(aq)}$
D.	$\text{CH}_3\text{COCH}_3_{(aq)}$	$\text{CH}_3\text{COOH}_{(aq)}$

24. Increased algal growth (algal bloom) is a problem in a river. Which of the following industries in the area should be investigated to determine whether chemical waste control and treatment are inadequate?
- A. Agricultural
 - B. Petrochemical
 - C. Nuclear power
 - D. Coal-fired power

25. A sample of lake water registered a pH reading of 5.83. The hydronium ion concentration $[\text{H}_3\text{O}^+_{(aq)}]$ for this sample is
- A. $6.8 \times 10^{-9} \text{ mol/L}$
 - B. $1.5 \times 10^{-6} \text{ mol/L}$
 - C. $1.5 \times 10^{-5} \text{ mol/L}$
 - D. 5.8 mol/L
26. An acid with a pH of 4.00 has the same concentration as an acid with a pH of 2.00. The acid with a pH of 4.00 is
- A. weaker and has a $[\text{H}_3\text{O}^+_{(aq)}]$ 100 times less than that of the other acid
 - B. stronger and has a $[\text{H}_3\text{O}^+_{(aq)}]$ 100 times less than that of the other acid
 - C. weaker and has a $[\text{H}_3\text{O}^+_{(aq)}]$ 100 times greater than that of the other acid
 - D. stronger and has a $[\text{H}_3\text{O}^+_{(aq)}]$ 100 times greater than that of the other acid

Use the following information to answer the next question.

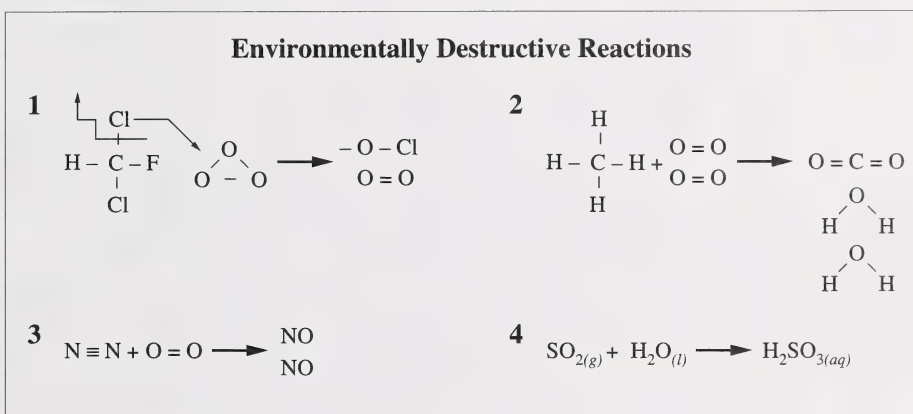
Considerations Associated With Adding Lime to Neutralize the Water in a Lake

- I Acidification varies with the amount of runoff.
- II Heavy metals may continue to leach into the lake.
- III Lime is insoluble.
- IV Lime is basic.

27. Adding lime, $\text{Ca}(\text{OH})_{2(s)}$, once a year to a lake may **not** solve all of the ecological problems associated with acid deposition because of considerations
- A. I and II
 - B. I and IV
 - C. II and III
 - D. III and IV

28. In an electrostatic precipitator at a coal-fired power plant, a plate attracts charged particles, thereby removing the particles from effluent gases before they go up a smokestack. When the distance between the two plates is 0.500 m, what voltage must be applied to produce an electric field strength of $3.00 \times 10^3 \text{ V/m}$?
- A. $1.50 \times 10^3 \text{ V}$
 B. $3.00 \times 10^3 \text{ V}$
 C. $6.00 \times 10^3 \text{ V}$
 D. $7.50 \times 10^2 \text{ V}$

Use the following information to answer the next question.



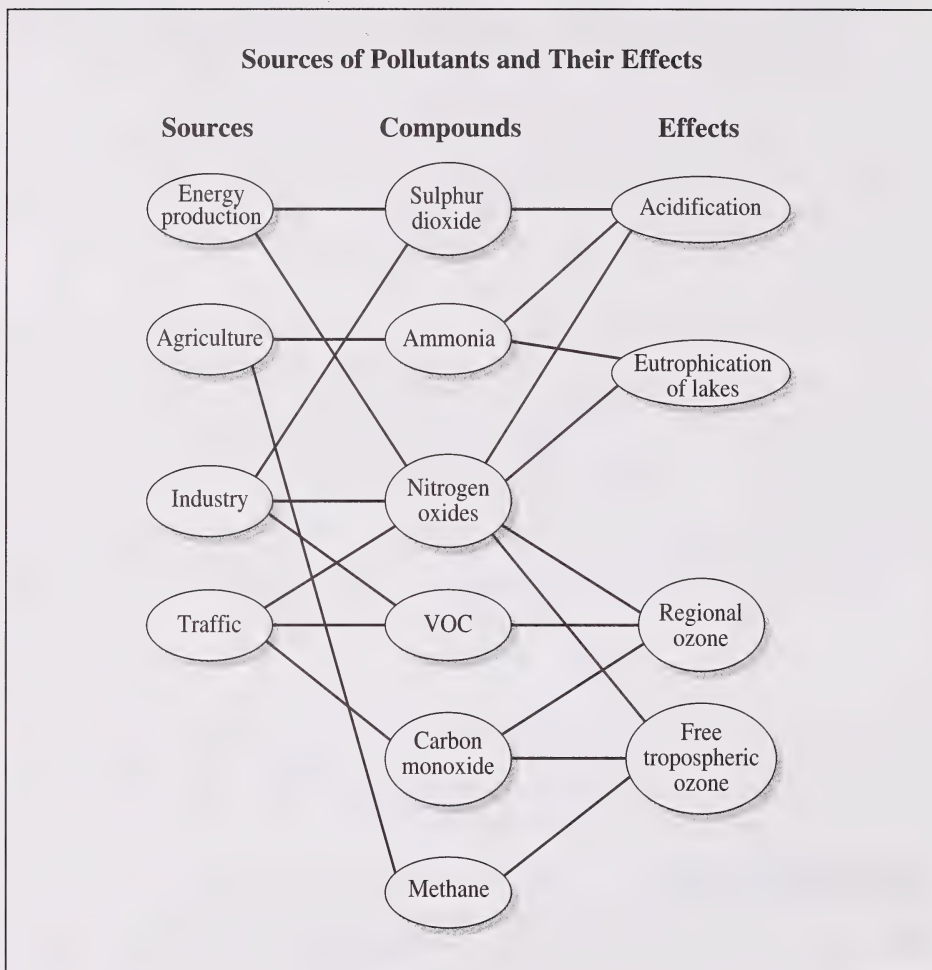
Numerical Response

7. Match each reaction numbered above with the environmental problem given below that it causes. Use each number only once.

Ozone depletion	_____	(Record in the first column.)
Acid deposition	_____	(Record in the second column.)
Photochemical smog	_____	(Record in the third column.)
Greenhouse effect	_____	(Record in the fourth column.)

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.



29. According to the diagram above, the greatest number of environmental effects are caused by which of the following compounds?
- A. Ammonia
 - B. Nitrogen oxides
 - C. Sulphur dioxide
 - D. Carbon monoxide

- 30.** As part of the 1987 Montreal Protocol, Canada committed to eliminating the use of chlorofluorocarbons (CFCs) by the year 2000. Which of the following environmental issues does the Montreal Protocol address?
- A.** Overpopulation
 - B.** Ozone depletion
 - C.** Global warming
 - D.** Acidic deposition
- 31.** The goal of using resources to meet the needs of the present generation without compromising the ability of future generations to meet their needs is referred to as
- A.** reclamation
 - B.** reforestation
 - C.** carbon balance
 - D.** sustainable development

Metropolitan areas consume large amounts of electrical energy that can be generated by different types of power plants.

Use the following information to answer the next question.

Technologies That Produce Energy

- 1** Natural gas furnace
- 2** Coal-fired power plant
- 3** Geothermal steam turbine
- 4** Two-way tidal dam
- 5** Diesel-powered generator
- 6** Wood-burning stove

Numerical Response

- 8.** The technologies listed above that use energy sources that originate from solar radiation are _____, _____, _____, and _____.

(Record **all four digits** of your answer in any order in the numerical-response section on the answer sheet.)

- 32.** Which of the following types of electrical power generating plants contribute to the greenhouse effect?
- A.** Coal-powered
 - B.** Tidal-powered
 - C.** Wind-powered
 - D.** Nuclear-powered

Use the following information to answer the next question.

**Steps in the Conversion of Solar Energy to the Electrical Energy
Produced by a Coal-Fired Generating Station**

1 **2** **3** **4**
Sun → Coal → Steam → Turbine → Generator

Numerical Response

- 9.** Match each of the steps numbered above with the description of its energy conversion given below.

Mechanical to electrical	_____	(Record in the first column.)
Chemical to thermal	_____	(Record in the second column.)
Thermal to mechanical	_____	(Record in the third column.)
Solar to chemical	_____	(Record in the fourth column.)

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

- 33.** Tidal energy is a renewable energy source. Tides are caused by
- A.** magnetic fields
 - B.** geothermal fields
 - C.** electrostatic fields
 - D.** gravitational fields

Use the following information to answer the next question.

Energy Sources

- 1 Controlled nuclear fission
- 2 Underground radioactive decay
- 3 Chemical potential energy
- 4 Gravitational potential energy

Numerical Response

- 10.** Match each of the energy sources numbered above with the appropriate type of power plant given below.

Geothermal _____ (Record in the **first** column.)

Hydroelectric _____ (Record in the **second** column.)

CANDU reactor _____ (Record in the **third** column.)

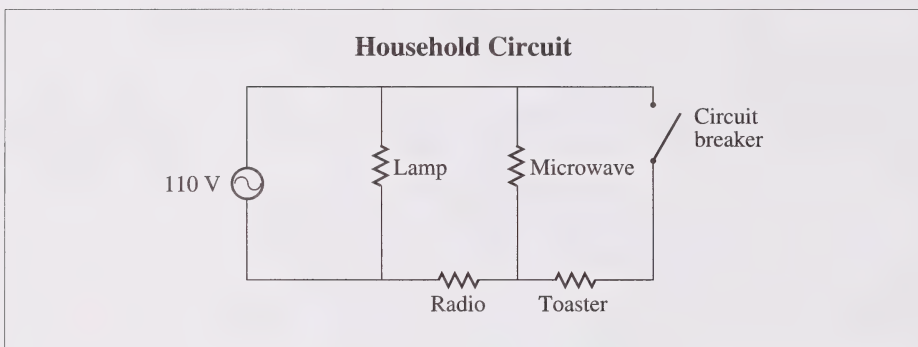
Coal-fired _____ (Record in the **fourth** column.)

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

- 34.** Electrical energy is transmitted from a power plant using
- A.** DC to avoid dangerous voltages
 - B.** AC to prevent radio interference
 - C.** AC to reduce transmission losses
 - D.** DC to improve instrument efficiency
- 35.** The step-up transformer at an electrical power-generating plant increases the voltage from 120 V to 24 000 V. If there are 300 turns in the primary coil, how many turns are there in the secondary coil?
- A.** 15.0
 - B.** 6.00×10^4
 - C.** 2.88×10^5
 - D.** 7.20×10^6

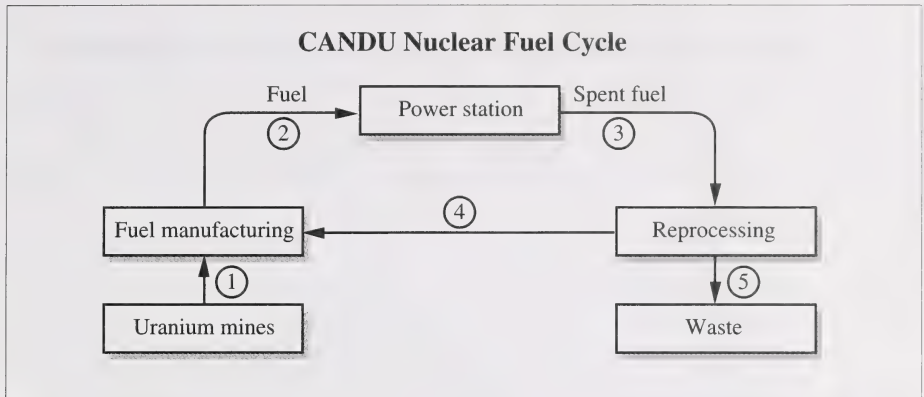
36. The electricity leaving a generating station passes through a number of transformers before it reaches a consumer. One reason to step down the voltage entering homes is that
- A. lower voltage moves slower
 - B. lower voltage is less dangerous
 - C. less heat is produced by lower voltage
 - D. more current results in a higher power bill

Use the following information to answer the next question.



37. According to the circuit diagram above, if the circuit breaker is off, which of the following appliances will **not** receive any current?
- A. Lamp
 - B. Radio
 - C. Toaster
 - D. Microwave
-
38. The CANDU reactor converts some fuel mass to fission products and gamma rays. When the speed, frequency, and wavelength of gamma rays are compared with visible light, gamma rays have
- A. lower speed, higher frequencies, and longer wavelengths
 - B. the same speed, lower frequencies, and longer wavelengths
 - C. the same speed, higher frequencies, and shorter wavelengths
 - D. higher speed, the same frequencies, and shorter wavelengths

Use the following information to answer the next three questions.



Numerical Response

- 11.** CANDU reactors are among the most efficient nuclear reactors in the world. If the input of a reactor is 153 units of energy and the output is 34.6 units of useful energy, then the efficiency of the reactor is _____%.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

- 39.** In the process depicted in the diagram, the difference between the “fuel” and the “spent fuel” is that the
- A. fuel is rich in cesium and the spent fuel is not
 - B. spent fuel is rich in uranium and the fuel is not
 - C. mass of the spent fuel is less than the mass of the fuel
 - D. mass of the fuel is less than the mass of the spent fuel
- 40.** If the waste from the CANDU fuel cycle were to come in contact with a living organism, it might change the base-pair sequence of a DNA strand. This change is called
- A. trisomy
 - B. sex-linkage
 - C. point mutation
 - D. nondisjunction

Province Energy Source	1 British Columbia	2 Alberta	3 Ontario	4 Quebec
Coal	—	34 146	34 020	—
Hydro	51 088	1 598	38 625	138 409
Natural gas	4 977	6 899	793	—
Nuclear	—	—	65 261	4 820
Oil	303	120	1 455	1 619
Other	1 293	572	283	—
Total	57 661	43 335	140 437	144 848

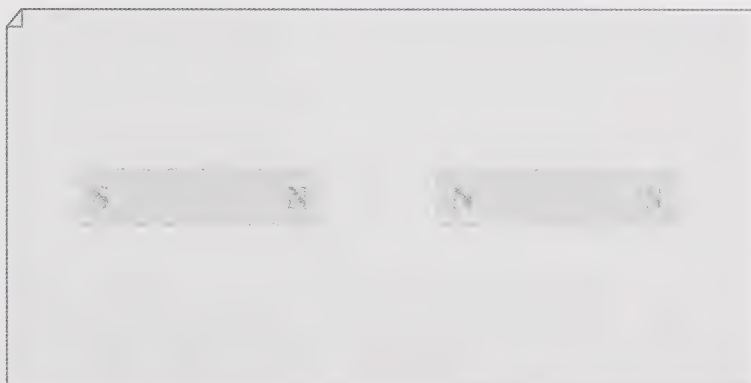
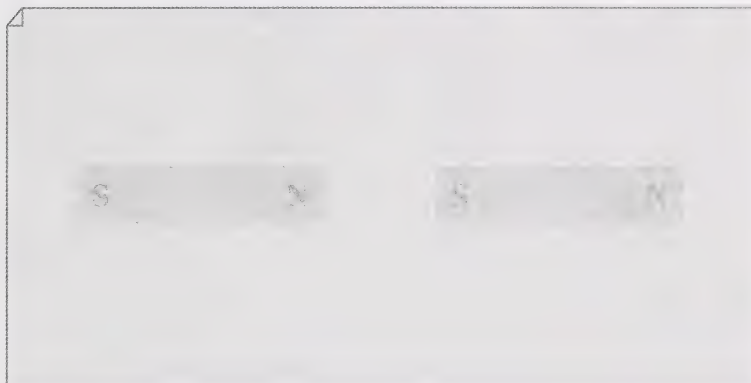
12. List the provinces in order from the one that produces the most energy from **renewable** resources to the one that produces the least energy from **renewable** resources.

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

Short Answer – 5%

Each of the diagrams below represents a sheet of paper placed on top of two magnets. If iron filings were sprinkled on the sheets, they would show the magnetic fields of the magnets below.

Sketch the complete magnetic fields that would be shown by the iron filings.



Use the following information to answer the next question.

Cars and trucks burn about half the oil produced worldwide.

Fuel Efficiency of Automobiles in the United States: 1989–1998

Year	Average Fuel Efficiency
1989	13.2 km/L
1990	13.7 km/L
1991	13.8 km/L
1992	13.8 km/L
1993	14.2 km/L
1994	14.9 km/L
1995	15.7 km/L
1996	15.9 km/L
1997	16.6 km/L
1998	17.0 km/L

Long Answer – 15%

1. a. Construct a graph using the information from the table.



- b.** Increased fuel efficiency of cars is an example of how technological advances have produced an environmental advantage with economic benefits. Compare the cost of driving a car that uses gasoline at a rate of 13.2 km/L with that of a car that uses gasoline at a rate of 17.0 km/L. Assume that an individual drives an average of 30 000 km/year for 10 years and that gasoline costs \$0.50/L for the entire time. Show your work.

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- c.** If current trends continue, the number of cars and trucks on the road could double by the year 2030. Outline your position on what should be done in the future to achieve sustainable development with regard to the automobile. Include examples of personal, political, and technological solutions in your answer.

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Long Answer – 15%

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